

AMENDMENT UNDER 37 C.F.R. § 1.116  
US Application No. 10/797,579  
Attorney Docket No. Q80074

**REMARKS**

Reconsideration and allowance of this application are respectfully requested. Claims 1, 2, 6, 7 and 9-13 are pending in the application. The rejections are respectfully submitted to be obviated in view of the remarks presented herein.

**Rejection Under 35 U.S.C. § 102(e) - Pancham et al.**

Claims 1, 2, 9 and 10 have been rejected under 35 U.S.C. § 102(e) as allegedly being anticipated by Pancham et al. (U.S. Patent Application Publication Number US 2005/0072525; hereinafter “Pancham”). The rejection is respectfully traversed.

Pancham was filed in the United States on October 6, 2003, which is after Applicants’ filing date of Korean Application Number 10-2003-0015154 (filed March 11, 2003), to which priority is claimed. Pancham cannot be considered prior art under any subsection of 35 U.S.C. § 102 / §103 because a verified English language translation of the foreign priority document (KPA 10-2003-0015154) is submitted concurrently. Reconsideration and withdrawal of the rejection under 35 U.S.C. § 102(e) are respectfully requested.

**Rejection Under 35 U.S.C. § 103(a) - Pancham et al. in view of Emami et al.**

Claims 6, 7 and 11-13 have been rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over Pancham in view of Emami et al. (U.S. Patent Application Publication Number US 2003/0070695; “Emami”). The rejection is respectfully traversed.

As discussed above, Pancham cannot be considered prior art under any subsection of 35 U.S.C. § 102 / §103 because a verified English language translation of the foreign priority document (KPA 10-2003-0015154) is submitted concurrently. Furthermore, Emami fails to

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teach or suggest every element of the claimed invention. Therefore, reconsideration and withdrawal of the rejection under 35 U.S.C. § 103(a) are respectfully requested.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,



Lenny R. Jiang  
Registration No. 52,432

SUGHRUE MION, PLLC  
Telephone: (202) 293-7060  
Facsimile: (202) 293-7860

WASHINGTON OFFICE  
23373  
CUSTOMER NUMBER

Date: June 19, 2006



## DECLARATION

I, Minjung Kwak, a Korean citizen of 8th Floor, Daelim Building 1600-3, Seocho-dong, Seocho-gu, Seoul, Korea, do hereby solemnly and sincerely declare as follows:

1. That I am well acquainted with the English and Korean languages.
2. That the following is a correct translation into English of the accompanying certified copy of a Korean Patent Application No. 2003-15154, and I make the solemn declaration conscientiously believing the same to be true.

A handwritten signature in black ink, appearing to read "Minjung Kwak".

Minjung Kwak  
June 15, 2006  
Seoul, Korea



DOCUMENT]

Application for Patent

[RIGHT] Patent

[TO] The commissioner

[SUBMISSION DATE] March 11, 2003

5 [TITLE OF THE INVENTION-KOREAN] 감광액 도포 스피н 코팅 장치

[TITLE OF THE INVENTION-ENGLISH] Spin coating apparatus for coating photoresist

[APPLICANT]

[NAME] Samsung Electronics Co., Ltd.

[APPLICANT CODE] 1-1998-104271-3

10 [EMPOWERED ATTORNEY]

[NAME] Hong-sik JEONG

[ATTORNEY CODE] 9-1998-000543-3

[GENERAL POWER OF ATTORNEY NO] 2003-002208-1

[INVENTOR]

15 [NAME-KOREAN] 이은성

[NAME-ENGLISH] LEE, EUN SUNG

[RESIDENT REGISTRATION NUMBER] 720831-1406418

[ZIP CODE] 301-758

[ADDRESS] 28-409, Samsung Apartment, Oryu-dong, Joong-gu, Daejeon

20 [NATIONALITY] KR

[INVENTOR]

[NAME-KOREAN] 좌성훈

[NAME-ENGLISH] CHOA, SUNG HOON

[RESIDENT REGISTRATION NUMBER] 600617-1046519

25 [ZIP CODE] 120-771

[ADDRESS] 102-1005, Byuksan Apartment, Hongeun-1-dong, Seodaemun-gu, Seoul

[NATIONALITY] KR

[INVENTOR]

[NAME-KOREAN] 최민석

30 [NAME-ENGLISH] CHOI, MIN SEO

[RESIDENT REGISTRATION NUMBER] 690109-1646414

[ZIP CODE] 138-040

[ADDRESS] 102, 395-18, Pungnab-dong, Songpa-gu, Seoul

[NATIONALITY] KR

[EXAMINATION REQUEST] YES

5 [PURPOSE] I, hereby, submit the present application for the Patent and request the examination of the present invention under the Article 42 and the Article 60 of the Patent Law.

Attorney

Hong-sik JEONG (seal)

[Official Fee]

	[Basic fee]	17	pages	₩29,000
10	[Additional fee]	0	pages	₩0
	[Claiming Priority Right]	0	case	₩0
	[Filing Request For Examination]	7	claims	₩333,000
	[Total]			₩362,000

[Documents] 1. One copy of Abstract, Specification (& drawings)

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## [ABSTRACT OF THE DISCLOSURE]

### [Abstract]

A spin coating apparatus for coating photoresist has a spin chuck and a nozzle part.

The spin chuck has a mount part on which a wafer is mounted and an extended projection part on which edge-bead is formed. The nozzle part is for depositing photoresist onto the wafer mounted on the mount part of the spin chuck. By using the spin coating apparatus, edge-bead is formed on the extended projection part, and not on the wafer. Therefore, it is unnecessary to perform the EBR (Edge-Bead Removal). Accordingly, the manufacturing cost of wafer is cut down and the usable area of the wafer is not reduced. As a result, reliability of the wafer is improved.

### [The main figure]

FIG. 4

### [Search term]

photoresist, spin chuck, extended projection part, gas exhaust part, spin coating

## [SPECIFICATION]

### [The title of the invention]

Spin coating apparatus for coating photoresist

### [The brief description of the drawings]

5 FIG. 1 is a schematic cross-sectional view of a conventional spin coating apparatus for coating photoresist;

FIG. 2 is a schematic cross-sectional view of a wafer having a photoresist layer formed thereon, after the EBR according to a related art;

10 FIG. 3 is a schematic cross-sectional view of a spin coating apparatus for coating photoresist according to the present invention;

FIG. 4 is a view explaining the separation of a wafer from a spin chuck provided with a separation part;

FIG. 5 is a schematic cross-sectional view of a spin coating apparatus for coating photoresist according to the present invention which further comprises a gas exhaust part;

15 FIG. 6 is a schematic cross-sectional view of a wafer on which a photoresist layer is formed using the spin coating apparatus for coating photoresist shown in FIG. 5; and

FIG. 7 is a schematic cross-sectional view of a spin coating apparatus for coating photoresist according to the present invention which further comprises a gas exhaust part

20 \*Description of the reference numerals in the drawings\*

100, 200, 300: nozzle part 120, 220, 320: wafer

140, 240, 340: spin chuck 144, 244: extended projection part

150a, 150b: separation part 260, 360: gas exhaust part

**[Detailed description of the invention]**

**[Object of the invention]**

**[The field of the invention and the related art]**

The present invention relates to an apparatus for coating photoresist on a wafer, and  
5 more particularly a spin coating apparatus for coating photoresist comprising a spin chuck  
provided with an extended projection so that an edge-bead is formed on the extended  
projection, not on a wafer.

Photoresist coating methods applied in the photoresist coating process include spin  
coating, spray coating and the like. Among them, the spin coating is most widely used.

10 The spin coating is performed by depositing photoresist at the center of a wafer  
mounted on a spin chuck and rotating the spin chuck so that the deposited photoresist is  
evenly spread on the wafer.

However, in the photoresist coating process by spin coating, there may be edge-bead  
formed at the edge of the wafer due to self-stress of the photoresist and stress between the  
15 photoresist and the wafer. The edge-bead may cause irregular development of photoresist.  
Also, in case of the contact alignment, the edge-bead may adhere to a mask, hindering an  
alignment.

In order to solve the above-described problems, the coating of photoresist is followed  
by a process to remove edge-bead. The process for removal of the edge-bead, or so-called  
20 EBR (Edge-Bead Removal) process is carried out by spraying a solvent which is capable of  
dissolving the photoresist at the edge of the wafer where the edge-bead is formed.

However, the EBR process may remove a photoresist layer as well as the edge-bead

at the edge of the wafer. As a result, the usable area of the wafer is reduced. For example, in case of a 4-inch wafer, the unusable area resulting from the edge-bead formation is approximately 1cm width from the outermost corner edge toward the inside center. Therefore, the usable area of the wafer after EBR is only 64% of the whole area of the wafer.

5 That is, about 36% of the whole area of the wafer cannot be used.

Further, the EBR may increase the cost needed for the manufacturing process of wafers.

Korean Patent Application No. 2000-0046000 discloses a spin coating apparatus, which enables both the process for coating photoresist on a wafer and the EBR.

10 FIG. 1 is a view schematically showing a cross-section of a conventional spin coating apparatus for coating photoresist, and FIG. 2 is a view schematically showing a cross-section of a wafer having photoresist applied thereon, after the EBR.

Referring to FIG. 1 and FIG. 2, a wafer 20 is mounted on a spin chuck 30 which has a diameter greater than that of the wafer 20. On the wafer 20, photoresist is applied to form a 15 photoresist layer 40. At the edge of the wafer 20, edge-bead 42 is formed due to excessive application of photoresist. A nozzle part 10 is provided at a predetermined distance upward from the wafer 20 to deposit photoresist at the center of the wafer 20.

The process for coating photoresist on a wafer using the spin coating apparatus for coating photoresist will be described in detail as follows.

20 Photoresist is deposited on the center of the wafer 20 through the nozzle part 10. The spin chuck 30 is rotated to evenly apply the deposited photoresist on the whole area of the wafer 20. The photoresist is evenly spread on the whole area of the wafer 20 by the

centrifugal force due to the rotation. However, at the edge of the wafer 20, the photoresist is excessively applied due to the self-stress of the photoresist and the stress between the photoresist and the wafer 20, thereby forming the edge-bead 42. Then, the EBR to remove the edge bead is performed by spraying an agent capable of dissolving the photoresist at the 5 edge of the wafer through a dissolvent nozzle part.

The EBR may remove the edge bead 42, however, the photoresist layer at the edge of the wafer 20 disappears, as shown in FIG. 2. Therefore, the usable area of the wafer is reduced. Further, there is a problem related to the incurrence of a cost for the EBR.

10 **[Technical object of the invention]**

Therefore, in an effort to overcome the problems as described above, it is an aspect of the present invention to provide a spin coating apparatus for coating photoresist comprising a spin chuck having a mount part on which a wafer is mounted and an extended projection part on which edge-bead is formed, and a nozzle part for depositing photoresist 15 onto the wafer mounted on the mount part of the spin chuck.

It is another aspect of the present invention to provide a coating method further comprising a gas exhaust part disposed so that gas is exhausted from the edge of the wafer in the turning direction of the wafer and the centrifugal direction upon rotation of the wafer.

In is still another aspect of the present invention to provide a spin coating apparatus 20 for coating photoresist, which further has a gas exhaust part disposed so that gas is exhausted from the edge of the wafer in the turning direction of the wafer and the centrifugal direction upon rotation of the wafer.

## [Construction and operation of the invention]

In accordance with the present invention, the above and other aspects and/or features can be accomplished by the provision of a spin coating apparatus for coating photoresist comprising a spin chuck having a mount part on which a wafer is mounted and an extended 5 projection part on which edge-bead is formed, and a nozzle part for depositing photoresist onto the wafer mounted on the mount part of the spin chuck.

According to the present invention, the extended projection part of the spin chuck has a height equal to, or lower than that of the wafer mounted on the mount part.

Also, the extended projection part of the spin chuck is formed to surround the 10 circumference of the wafer while being in contact with the circumference of the wafer mounted on the mount part.

Meanwhile, the spin chuck may further comprise a separation part for separating the wafer from the spin chuck.

Further, the spin coating apparatus for coating photoresist may further comprise a gas 15 exhaust part disposed so that gas is exhausted from the edge of the wafer in the turning direction of the wafer and the centrifugal direction upon rotation of the wafer.

Thus, the spin coating apparatus for coating photoresist according to the present invention comprises a spin chuck for rotating a wafer, a nozzle part for depositing photoresist onto the wafer mounted on the spin chuck and a gas exhaust part disposed so that gas is 20 exhausted from the edge of the wafer in the turning direction of the wafer and the centrifugal direction upon rotation of the wafer.

Now, the spin coating apparatus for coating photoresist according to the present

invention will be described in detail with reference to the drawings.

FIG. 3 is a schematic cross-sectional view of a spin coating apparatus for coating photoresist according to the present invention.

As shown in FIG. 3, a spin chuck 140 includes a mount part 142 on which a wafer

5 120 is mounted and an extended projection part 144 on which edge-bead is formed.

The mount part 142 has the same shape as a conventional spin chuck.

The extended projection part 144 is extended to a predetermined distance from the

mount part 142 and then projected upward. The extended projection part 144 is formed to

have a height that is not higher, but lower than that of the wafer 120 mounted on the mount

10 part 142 of the spin chuck 140. If the extended projection part 144 has a height higher than

that of the wafer 120 mounted on the mount part 142, the photoresist spread by the

centrifugal force cannot further progress due to the extended projection part 144 but is

gathered in front of the extended projection part 144. As a result, the edge-bead is still

formed on the wafer 120.

15 Meanwhile, in FIG. 3, the extended projection part 144 is shown to have a height that

is lower than that of the wafer 120 mounted on the mount part 142, however, the extended

projection part 144 may have a height equal to that of the wafer 120 mounted on the mount

part 142.

The extended projection part 144 is formed to surround the circumference of the

20 wafer 120 while being in contact with the circumference of the wafer 120 mounted on the

mount part 142. This is because the photoresist spread by the rotation of the spin chuck may

escape between the extended projection part 144 and the wafer 120 to form edge-bead on the

wafer 120 when the extended projection part 144 is not in contact with the circumference of the wafer 120.

As shown in FIG. 3, the edge-bead 162 is formed on the extended projection part 144, not on the wafer 120. Preferably, the extended projection part 144 has a width at its upper 5 part greater than or equal to that of the unusable area of the wafer defined by the edge edge-bead 162.

FIG. 4 is a view explaining the separation of a wafer from a spin chuck provided with a separation part;

After forming a photoresist layer 160, in order to more easily separate the wafer 120 10 from the spin chuck 140, the spin chuck 140 is provided at its lower surface with separation parts 150a, 150b. The separation of the wafer 120 from the spin chuck 140 is performed by inserting the separation members 180a, 180b into the separation parts 150a, 150b to push the bottom of the wafer 120. By this, the wafer 120 can be readily separated from the spin chuck 140 without damage of the photoresist layer 160 formed on the wafer 120.

15 Meanwhile, though two separation parts 150a, 150b are shown in FIG. 4, two or more of separation parts can be formed.

FIG. 5 is a schematic cross-sectional view of a spin coating apparatus for coating photoresist according to the present invention which further comprises a gas exhaust part.

When photoresist is coated using the spin coating apparatus shown in FIG. 3, the 20 edge-bead is formed on the extended projection part. However, if an excessive amount of photoresist is applied on the extended projection part, a little edge-bead can be formed at the edge of the wafer.

Therefore, in order for the edge-bead 282 not to be formed on the wafer 220 at all but only to be formed on the extended projection part 282, it is preferable to use a spin coating apparatus for coating photoresist further comprising a gas exhaust part 260 disposed so that gas is exhausted from the edge of the wafer in the turning direction of the wafer and the 5 centrifugal direction upon rotation of the wafer.

As shown in FIG. 5, a wafer 220 is mounted on a mount part 242 of a spin chuck 240. The mounted wafer 220 has a height higher than that of the extended projection part 244, as explained with reference to FIG. 3. A nozzle part 200 is disposed at a predetermined distance from the wafer 220 to deposit photoresist at the center of the wafer 220. Also, a 10 gas exhaust part 260 is disposed at a predetermined place so that gas is exhausted from the edge of the wafer in the turning direction of the wafer and the centrifugal direction upon rotation of the wafer.

The application of the spin coating apparatus for coating photoresist is described as follows.

15 The wafer 220 is mounted on the mount part 242 of the spin chuck 240 and photoresist is deposited at the center of the wafer 220 through the nozzle part 200. Then, the spin chuck 240 is rotated to evenly spread the photoresist on the wafer 220 and the extended projection part 244.

Meanwhile, while the photoresist is applied on the wafer 220 and the extended 20 projection part 244, gas is exhausted over the wafer 220 through the gas exhaust part 260. Here, the gas is exhausted in the turning direction of the wafer 220 and the centrifugal direction upon rotation of the wafer and also exhausted from the edge of the wafer 220, that is,

from the area where the wafer 220 comes in contact with the extended projection part 244. If the gas exhaust direction is reverse to the turning direction of the wafer 220 and the centrifugal direction, or the gas is exhausted from any other region than the region where the wafer 220 comes in contact with the extended projection part 244, the edge-bead 282 may be  
5 formed any other region than the extended projection part 244.

FIG. 6 shows a schematic cross-sectional view of a wafer 220 on which a photoresist layer 280 is formed by the above procedures. There is not edge-bead formed at the edge of the wafer 220. Therefore, the wafer 220 shown in FIG. 6 has a usable area substantially equal to the whole area of the wafer.

10 FIG. 7 is a schematic cross-sectional view of a spin coating apparatus for coating photoresist according to the present invention which further comprises a gas exhaust part.

When photoresist is coated using the spin coating apparatus shown in FIG. 3 or FIG. 5, few edge-bead is formed on the wafer.

However, it is possible to prevent edge-bead from forming on the wafer 320 without  
15 the spin chuck as shown in FIG. 3 and FIG. 5. In other words, the edge-bead formation on the wafer 320 can also be prevented by using a spin coating apparatus, which has a conventional spin chuck 340, a nozzle part 300 for depositing photoresist onto the wafer 320 mounted on the spin chuck 340 and a gas exhaust part 360 disposed so that gas is exhausted from the edge  
20 of the wafer 320 in the turning direction of the wafer 320 and the centrifugal direction upon rotation of the wafer 320.

As shown in FIG. 7, edge-bead is not formed on the wafer 320. Therefore, the EBR becomes unnecessary and the usable area of the wafer is maximized, whereby the reliability

of the wafer is improved.

**[Effect of the invention]**

According to the present invention, by using a spin coating apparatus for coating  
5 photoresist comprising a spin chuck having a mount part on which a wafer is mounted and an  
extended projection part on which edge-bead is formed, and a nozzle for depositing  
photoresist onto the wafer mounted on the mount part of the spin chuck, photoresist can be  
applied without forming edge-bead on the wafer. As a result, the EBR is not needed,  
whereby it is possible to obtain the effect to cut down the manufacturing cost of the wafer.

10 Also, since the usable area of the wafer is not reduced even when the EBR is omitted,  
the reliability of the wafer can be improved.

Meanwhile, it is possible to obtain the above-described effect by using a spin coating  
apparatus for coating photoresist comprising a gas exhaust part disposed so that gas is  
exhausted from the edge of the wafer in the turning direction of the wafer and the centrifugal  
15 direction upon rotation of the wafer, without the spin chuck as described above.

Although the preferred embodiments of the present invention have been disclosed for  
illustrative purposes, those of ordinary skill in the art will appreciate that the present  
invention is not limited to the particular embodiments described above but various changes,  
modifications and variations can be made, without departing from the scope and spirit of the  
20 invention as claimed in the accompanying claims and such changes fall within the scope of  
the following claim.

**[What is claimed is]**

1. A spin coating apparatus for coating photoresist comprising a spin chuck having a mount part on which a wafer is mounted and an extended projection part on which edge-bead is formed; and

5 a nozzle for depositing photoresist onto the wafer mounted on the mount part of the spin chuck.

2. The spin coating apparatus according to claim 1, wherein the extended projection part of the spin chuck has a height lower than that of the wafer mounted on the mount part.

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3. The spin coating apparatus according to claim 1, wherein the extended projection part of the spin chuck has a height equal to that of the wafer mounted on the mount part.

4. The spin coating apparatus according to claim 1, wherein the extended projection part of the spin chuck is formed to surround the circumference of the wafer while being in contact with the circumference of the wafer mounted on the mount part.

15 5. The spin coating apparatus according to claim 1, wherein the spin chuck further comprise a separation part for separating the wafer from the spin chuck.

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6. The spin coating apparatus according to claim 1, which further comprises a gas exhaust part disposed so that gas is exhausted from the edge of the wafer in the turning

direction of the wafer and the centrifugal direction upon rotation of the wafer.

7. A spin coating apparatus for coating photoresist comprising:

a spin chuck for rotating a wafer;

5 a nozzle part for depositing photoresist onto the wafer mounted on the spin chuck;

and

a gas exhaust part disposed so that gas is exhausted from the edge of the wafer in the turning direction of the wafer and the centrifugal direction upon rotation of the wafer.